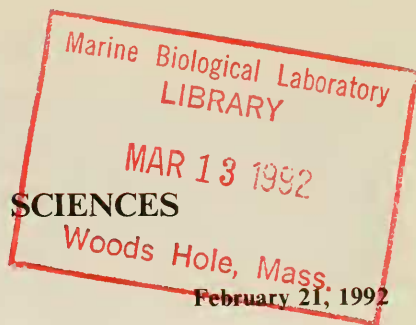


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ONISCIDEA (ISOPODA) OF THE
SAN FRANCISCO BAY AREA

By

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ABSTRACT: From June 1975 to May 1991 we collected samples of Isopoda, Oniscidea from 176 sites in the area surrounding San Francisco Bay, California, including the outer coast from Bolinas Lagoon, Marin County to Half Moon Bay, San Mateo County. Seventeen species of isopods were represented in these collections. Nine of these species were entirely restricted to littoral habitats, and the remaining eight were found in a variety of habitats. Eleven of the species are native to western North America, and the remaining six species are introductions from the Old World. Two of the species collected have not been previously reported from San Francisco Bay. All 19 species known or expected in the San Francisco Bay Area are discussed and figured, and a key and information concerning their distributions both within the Bay Area and throughout North America are provided. The results of this survey are discussed in relation to previous reports, and several errors in the literature concerning the oniscid isopods of the San Francisco Bay Area are corrected.

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INTRODUCTION

Even though the San Francisco Bay Area (referred to in this report as the Bay Area) has been the subject of a long history of zoologic study, information concerning Isopoda, Oniscidea of this region has been sparse. The more significant reports dealing with this area that concern this group have been those of Stuxberg (1875), Arcangeli (1932), and Miller (1938). Miller's work comprised the only comprehensive survey of this

group in the Bay Area, and little has been done on the oniscids of this area in the 53 years since its publication. In summarizing existing reports and his own collections, Miller (1938) listed a total of 19 oniscid isopods from the Bay Area. However, in the course of our studies on San Francisco Bay oniscids, we have found Miller's list outdated and inaccurate in several respects. As the literature stands, it would be difficult for anyone not intimately familiar with this group to accurately identify to species the oniscid isopods from this area.

These observations led us to conduct an extensive survey of the oniscid isopods of the San Francisco Bay Area. In this paper we report the results of this survey. An updated list of species, figures, and a key to the Bay Area oniscids are presented. Our results are discussed in relation to previous reports on the oniscids of this area.

MATERIALS AND METHODS

From June 1975 to May 1991 samples of oniscid isopods were collected from 176 sites in the Bay Area (see Fig. 1 for sampling locations and Table 1 for details of collection sites). A variety of habitats are represented by these collection sites. However, littoral habitats were emphasized and riparian habitats were infrequently sampled. Most of the collections included in this survey were made from January 1989 to May 1991, but these were supplemented with a number of samples from our collections made as early as 1975.

Isopods were collected by hand from an area of usually less than two square meters, preserved in the field in 70% ethanol, and transported to the laboratory where they were identified using the following references: Arcangeli (1932), Hatch (1947), Menzies (1950), Miller (1975), Mulaik and Mulaik (1942), Richardson (1905), Schultz (1984), Schultz et al. (1982), and Van Name (1936, 1940). Representative specimens have been deposited in the Department of Invertebrate Zoology and Geology at the California Academy of Sciences (catalog nos. CASIZ 075314–075578) and the Department of Invertebrate Zoology, Santa Barbara Museum of Natural History (catalog Nos. SBMNH 35353–35450).

RESULTS

With this survey the number of species of oniscid isopods known or expected from the San Francisco Bay Area is 19. A list of these species and the sites at which they were collected is given in Table 2.

Nine of the species collected were entirely restricted to littoral habitats: *Ligia occidentalis* Dana, 1853; *Ligia pallasii* Brandt, 1833; *Littorophiloscia richardsonae* (Holmes and Gay, 1909); *Mauritaniscus littorinus* (Miller, 1936); *Detonella papillicornis* (Richardson, 1904); *Armadilloniscus coronacapitalis* Menzies, 1950; *Armadilloniscus lindahli* (Richardson, 1905); *Armadilloniscus holmesii* Arcangeli, 1933; and *Alloniscus*

perconvexus Dana, 1856. Two species were riparian: *Ligidium latum* Jackson, 1923 and *Ligidium gracile* (Dana, 1856). The remaining six species were found in a variety of terrestrial habitats: *Protrichoniscus heroldi* Arcangeli, 1932; *Porcellio scaber* Latreille, 1804; *Porcellio dilatatus* Brandt and Ratzeburg, 1833; *Porcellio laevis* Latreille, 1804; *Porcellionides floria* Garthwaite and Sassaman, 1985; and *Armadillidium vulgare* (Latreille, 1804). Eleven of the species collected are Pacific Coast endemics (*L. occidentalis*, *L. pallasii*, *L. latum*, *L. gracile*, *P. heroldi*, *L. richardsonae*, *D. papillicornis*, *A. coronacapitalis*, *A. lindahli*, *A. holmesii*, and *A. perconvexus*), and the remainder are introductions from Europe (*P. scaber*, *P. dilatatus*, *P. laevis*, *P. floria*, and *A. vulgare*) and possibly Africa (*M. littorinus*).

Key to the Oniscid Isopods of the San Francisco Bay Area

- 1a. Flagellum of antenna two composed of more than 10 articles. Antenna one small but conspicuous 2
- 1b. Flagellum of antenna two composed of 6 or fewer articles. Antenna one usually minute and inconspicuous 5
- 2a. Both rami of uropod inserted distally on peduncle 3
- 2b. Exopod of uropod inserted proximal to endopod on peduncle 4
- 3a. Distance between eyes equal to length of one eye. Basal article of uropod several times longer than broad (Fig. 2) 1. *Ligia occidentalis*
- 3b. Distance between eyes equal to twice length of one eye. Basal article of uropod about as broad as long (Fig. 3) 2. *Ligia pallasii*
- 4a. Surface of body smooth and shiny, lacking conspicuous scales 4. *Ligidium gracile*
- 4b. Surface of body rough, with sparse scales. 3. *Ligidium latum*
- 5a. Eyes absent. Pereopod seven with conspicuous tuft of setae on upper margin of distal article (Fig. 6) 5. *Protrichoniscus heroldi*
- 5b. Eyes present. Pereopod seven without tuft of setae on upper margin of distal article. 6
- 6a. Flagellum of antenna two composed of 3–5 articles 7

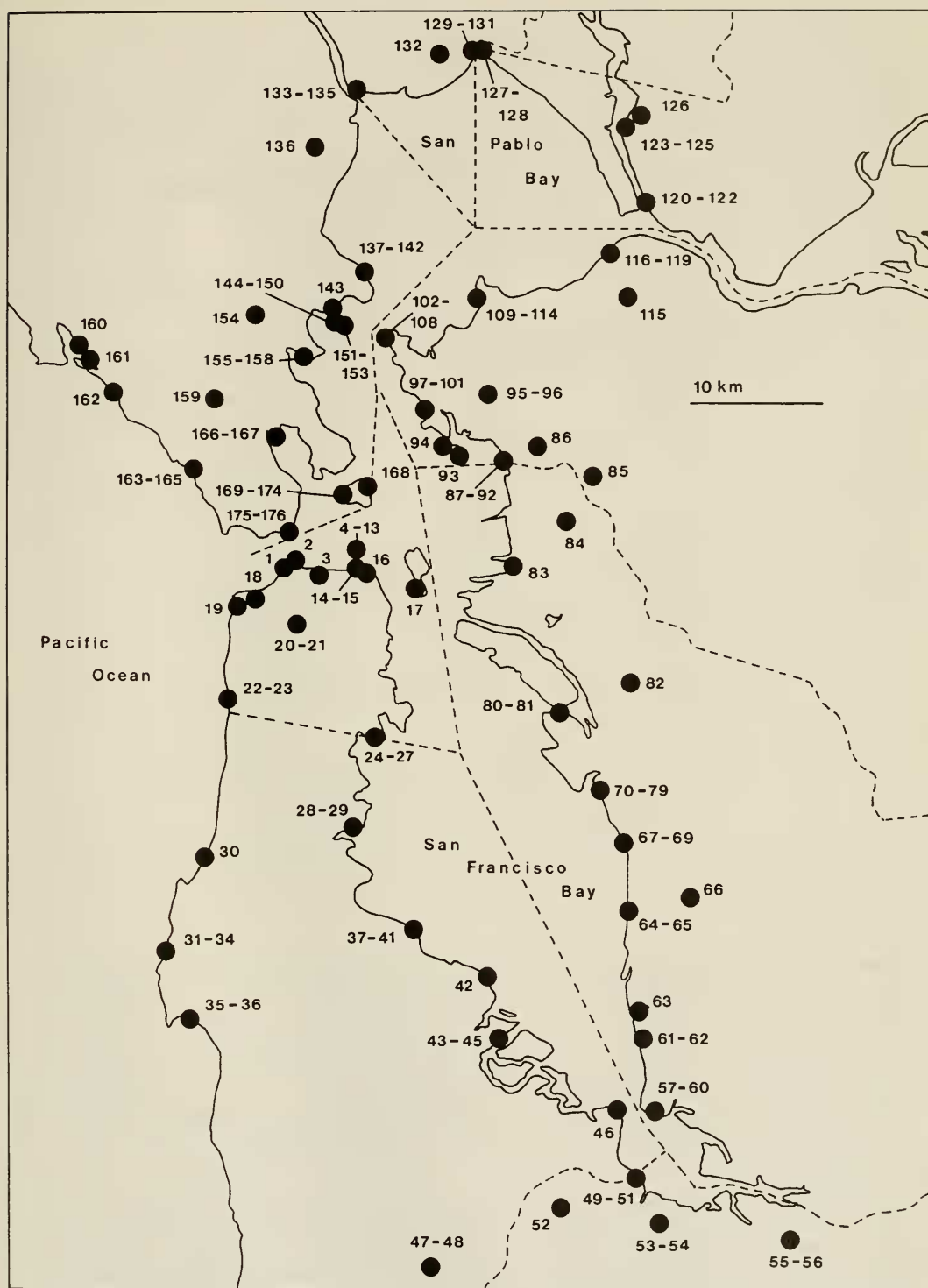


FIGURE 1. Map of the San Francisco Bay Area showing the location of all 176 collection sites referred to in this study. Dashed lines represent county boundaries.

TABLE 1. COLLECTION SITES.

Collection site	Date	Locality
San Francisco County:		
1	6 Apr 1989	San Francisco, ocean side of Fort Point
2	6 Apr 1989	San Francisco, Fort Point National Historic Site
3	13 Feb 1980	San Francisco, Palace of Fine Arts
4-13	10 Jun 1989	San Francisco, Alcatraz Island
14	6 Apr 1989	San Francisco, Fort Mason
15	6 Apr 1989	San Francisco, Aquatic Park
16	7 Dec 1979	San Francisco, corner of Levenworth and Beach
17	26 May 1988	San Francisco, Yerba Buena Island
18	5 Dec 1979	San Francisco, Palace of the Legion of Honor
19	26 Dec 1979	San Francisco, Sutro Heights Park
20	6 Dec 1979	San Francisco, Golden Gate Park, Temple of Music
21	30 May 1989	San Francisco, Golden Gate Park, Strybing Arboretum
22-23	Aug 1989	San Francisco, Fort Funston
24-27	6 Apr 1989	San Francisco, corner of Harney and Jamestown
San Mateo County:		
28-29	6 Apr 1989	South San Francisco, corner of Utah and Littlefield
30	Aug 1989	Pacifica, Rockaway Beach
31	26 Dec 1979	Montara
32-34	Aug 1989	Montara State Beach
35-36	Aug 1989	El Granada, Pillar Point Harbor
37-40	6 Apr 1989	Burlingame, corner of Airport and Lang
41	6 Apr 1989	San Mateo, Coyote Point Municipal Park
42	26 Feb 1989	Foster City
43-45	20 May 1989	San Carlos, Steinberger Slough
46	8 Apr 1989	Ravenswood Bird Observatory
47-48	30 Jul 1989	Portola Valley, corner of Alpine and Portola
Santa Clara County:		
49	12 Feb 1989	Palo Alto, mouth of San Francisquito Creek
50	12 Feb 1989	Palo Alto, Palo Alto Airport
51	12 Feb 1989	Palo Alto, yacht harbor
52	21 Jun 1975	Palo Alto, Stanford University
52	3 May 1991	Palo Alto, Stanford University
53-54	12 Feb 1989	Mountain View, Mountain View Tidal marsh
55-56	12 Feb 1989	Alviso, Alviso Marina County Park
Alameda County:		
57-60	14 May 1989	Fremont, one mile south of Dumbarton Bridge
61-63	8 Apr 1989	Fremont, Coyote Hills Regional Park
64-65	21 Apr 1989	Hayward, end of Breakwater Avenue
66	15 Nov 1979	Hayward, Western Blvd.
67-69	14 May 1989	San Lorenzo, Hayward Regional Shoreline
70-72	21 Apr 1989	San Leandro, San Leandro Marina
73-79	6 May 1989	San Leandro, San Leandro Marina
80-81	29 Nov 1980	Alameda, Bay Farm Island
82	21 Dec 1978	Oakland, corner of Maxwell and Brookdale
83	10 Jun 1989	Emeryville, corner of I-80 and Powell
84	11 Apr 1989	Berkeley, University of California
Contra Costa County:		
85	22 Dec 1978	Tilden Regional Park, Lake Anza
86	27 Dec 1978	El Cerrito, Clayton Street
87-92	22 Apr 1989	Richmond, Point Isabel Regional Park
93-94	9 Jun 1988	Richmond, Brooks Island
95	11 Nov 1978	Richmond, corner of 39th and Barrett
96	4 Dec 1979	Richmond, corner of 39th and Barrett
97-100	27 Mar 1989	Richmond, Point Richmond

TABLE 1. CONTINUED.

Collection site	Date	Locality
101	14 Nov 1979	Richmond, Point Richmond
102-103	10 Apr 1988	East Brothers Island
104-108	19 Mar 1990	East Brothers Island
109-114	26 Mar 1989	Point Pinole Regional Shoreline
115	13 Feb 1980	Rodeo, Seascape Circle
116-119	7 Apr 1989	Rodeo, San Pablo Avenue
Solano County:		
120-122	5 Nov 1989	Vallejo, near corner of Lemon and Alden
123-125	5 Nov 1989	Vallejo, Hwy. 37 at east shore of Mare Island Strait
126	7 Apr 1989	Vallejo, corner of Hwy. 37 and Sacramento St.
127-128	5 Nov 1989	mouth of Sonoma Creek, east shore
Sonoma County:		
129-131	5 Nov 1989	mouth of Sonoma Creek, west shore
132	5 Nov 1989	Hwy. 37 at Tolay Creek
133-135	5 Nov 1989	Port Sonoma Marina
Marin County:		
136	5 Nov 1989	Hwy. 37 at Novato Creek
137-139	28 May 1989	China Camp State Park
140-142	10 Jun 1989	China Camp State Park
143	28 May 1989	San Rafael, Loch Lomond Marina
144-150	17 Feb 1990	West Marin Island
151-153	14 Jan 1989	East Marin Island
154	20 Feb 1982	San Rafael, Latham Street
155-158	6 Apr 1989	San Quentin State Prison
159	27 Sep 1986	Muir Woods National Monument
160	30 May 1986	Bolinas Lagoon
161	27 Sep 1986	Bolinas Lagoon
162	30 May 1986	Stinson Beach
163-165	30 May 1989	Muir Beach
166-167	11 Mar 1989	Marin City, end of Pohono Street
168	6 Jun 1990	Angel Island State Park
169-174	2 Apr 1989	Angel Island State Park
175-176	11 Mar 1989	Lime Point, north end of Golden Gate Bridge

- 6b. Flagellum of antenna two composed of 2 articles 13

7a. Flagellum of antenna two composed of 3 articles 8

7b. Flagellum of antenna two composed of 4-5 articles 10

8a. Body flattened. No cone-shaped process below eye (Fig. 7) 6. *Littorophiloscia richardsonae*

8b. Body somewhat convex dorsally. With cone-shaped processes below eyes 9

9a. Endopod of pleopod one of male expanded near tip. Posterolateral margin of basal segment of uropod not greatly produced (Fig. 13) 12. *Alloniscus perconvexus*
- 9b. Endopod of pleopod one of male not expanded near tip. Posterolateral margin of uropod usually produced (Fig. 14) 13. *Alloniscus mirabilis*

10a. Uropods extending well beyond posterior body margin. Peduncle of antenna two with numerous tubercle-like papillae surmounted with tufts of setae (Fig. 9) 8. *Detonella papillicornis*

10b. Uropods not extending much beyond posterior body margin. Peduncle of antenna two without tubercle-like papillae or tufts of setae 11

11a. Capable of conglobation. Rostrum truncate (Fig. 11) 10. *Armadilloniscus lindahli*

TABLE 2. DISTRIBUTION OF ONISCID ISOPOD SPECIES AMONG COLLECTION SITES. SEE FIGURE 1, TABLE 1 FOR THE LOCATIONS OF THE COLLECTION SITES.

Species	Collection sites
Ligiidae	
^a <i>Ligia occidentalis</i>	12, 14, 24, 29, 30, 39, 68, 70, 72, 78, 88, 98, 102, 113, 118, 120, 139, 143, 144, 152, 156, 161, 164, 166, 171, 172, 176
^a <i>Ligia pallasii</i>	1, 33
^a <i>Ligidium latum</i>	162, 163
^a <i>Ligidium gracile</i>	163
Trichoniscidae	
^a <i>Protrichoniscus heroldi</i>	110, 114, 159
Halophilosciidae	
^a <i>Littorophiloscia richardsonae</i>	24, 30, 35, 49, 54, 59, 63, 70, 89, 111, 113, 117, 127, 131, 137, 138, 140, 141, 161, 173
Bathythropidae	
^a <i>Mauritaniscus littorinus</i>	22, 25, 26, 27, 29, 38, 40, 42, 46, 50, 56, 61, 62, 65, 67, 68, 73, 75, 80, 143, 160, 165
Scyphacidae	
<i>Detonella papillicornis</i>	25, 42, 89, 97, 99, 100, 122, 143, 144, 150, 151, 155, 158, 160, 173
<i>Armadilloniscus coronacapitalis</i>	25, 29, 42, 43, 45, 49, 54, 59, 60, 63, 70, 83, 92, 111, 117, 119, 124, 128, 134, 137, 138, 140, 160, 161, 170
^a <i>Armadilloniscus lindahli</i>	25, 51, 54, 60, 67, 73, 79, 81, 99, 160, 161
^a <i>Armadilloniscus holmesi</i>	15, 25, 37, 40, 42, 68, 70, 73, 76, 79, 87, 92, 97, 99, 150, 151, 161, 166, 173
Oniscidae	
^a <i>Alloniscus perconvexus</i>	22, 23, 113
^b <i>Alloniscus mirabilis</i>	
Porcellionidae	
^a <i>Porcellio scaber</i>	2, 6, 8, 9, 10, 11, 12, 13, 16, 18, 19, 20, 21, 22, 30, 31, 34, 47, 48, 52, 84, 85, 93, 94, 95, 96, 97, 101, 105, 108, 123, 124, 126, 127, 128, 130, 134, 135, 136, 138, 141, 142, 145, 146, 147, 149, 153, 160, 163, 165, 168, 169, 174, 175
^a <i>Porcellio dilatatus</i>	3, 4, 5, 6, 7, 10, 11, 17, 20, 21, 31, 32, 36, 47, 48, 50, 52, 66, 82, 104, 105, 108, 109, 110, 112, 115, 136, 141, 147, 153, 168, 175
^a <i>Porcellio laevis</i>	28, 41, 42, 44, 50, 52, 53, 55, 58, 66, 69, 74, 80, 90, 91, 101, 112, 113, 114, 115, 143, 157
^a <i>Porcellionides floria</i>	52, 107, 115, 154
Armadillidiidae	
^a <i>Armadillidium vulgare</i>	8, 9, 11, 16, 17, 21, 26, 30, 31, 41, 42, 50, 52, 53, 55, 57, 61, 64, 66, 68, 71, 77, 80, 82, 85, 86, 90, 93, 94, 95, 96, 97, 101, 103, 106, 110, 112, 114, 115, 116, 121, 125, 126, 129, 132, 133, 135, 136, 137, 138, 142, 143, 148, 153, 154, 158, 160, 165, 167, 169, 175
Armadillidae	
^a <i>Venezillo microphthalmus</i>	

^a Reported from the San Francisco Bay Area by Miller (1938).
^b Not yet reported from the Bay Area but occurrence there likely.

- 11b. Not capable of conglobation. Rostrum acute 12

12a. Penultimate article of peduncle of second antenna with hooked flange on lateral border. Surface of body of mature female covered with conspicuous tubercles (Fig. 10) 9. *Armadilloniscus coronacapitalis*

12b. Penultimate article of peduncle of second antenna without hooked flange. Surface of body relatively smooth, with low rounded tubercles (Fig. 12) 11. *Armadilloniscus holmesi*

13a. Surface of body covered with fine scales. Exopod of pleopod one of male with knob-like process on inner margin (Fig. 8) 7. *Mauritaniscus littorinus*

13b. Surface of body smooth or not, but not

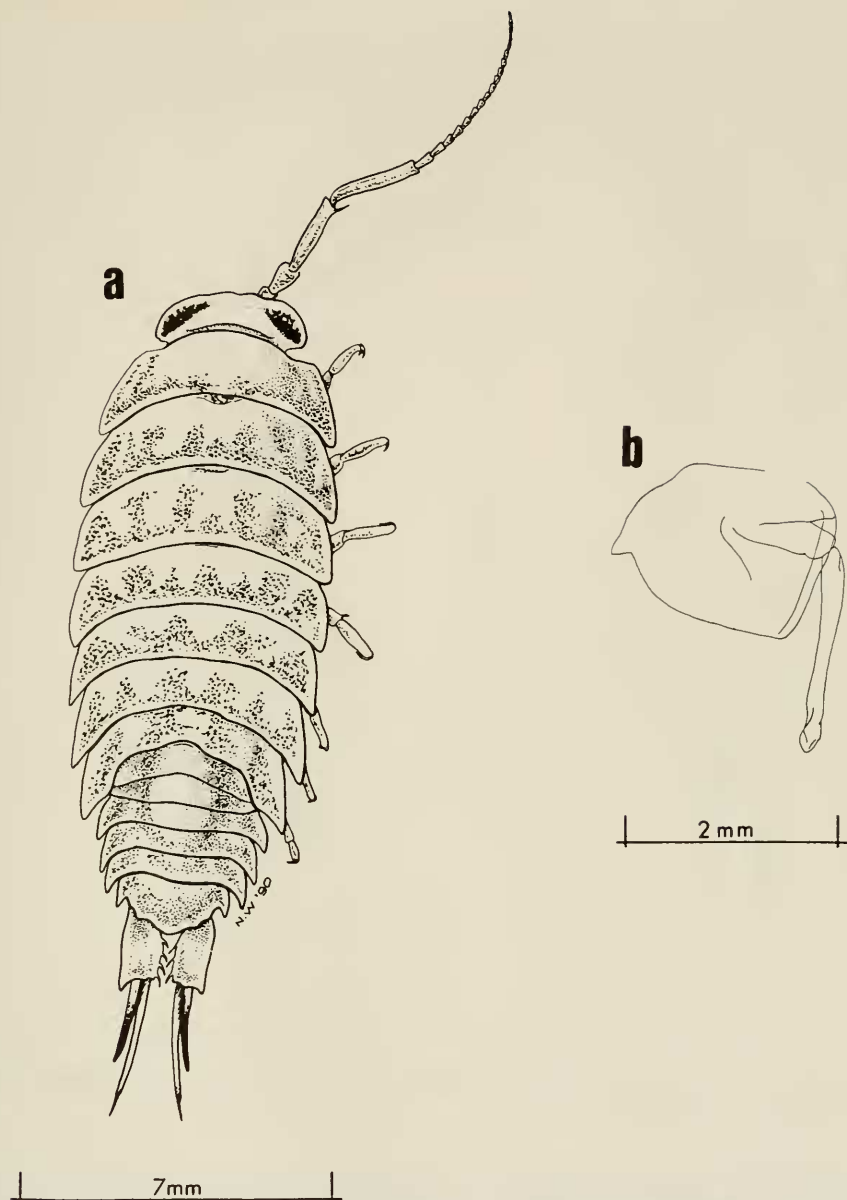


FIGURE 2. *Ligia occidentalis*: a, dorsal view; b, right male pleopod 2. Original drawings by Nancy Walker from CASIZ 075510.

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|---|----|---|----------------------------------|
| adorned with scales. No knob-like process on exopod of pleopod one | 14 | ginal lobes on cephalon. Pleon abruptly narrower than pereon (Fig. 18) | 17. <i>Porcellionides floria</i> |
| 14a. Not capable of conglobating. Uropods extending well beyond posterior body margin | 15 | 15b. Without a bloom or frost. Distinct frontal and/or marginal lobes on cephalon. Pleon continuous with pereon | 16 |
| 14b. Capable of conglobating. Uropods not extending beyond posterior body margin | 18 | 16a. Surface of body smooth. Posterolateral margin of pereonite one barely produced posteriorly (Fig. 17) | 16. <i>Porcellio laevis</i> |
| 15a. Usually with a waxy bloom or frosted appearance in life. No frontal or mar- | | | |

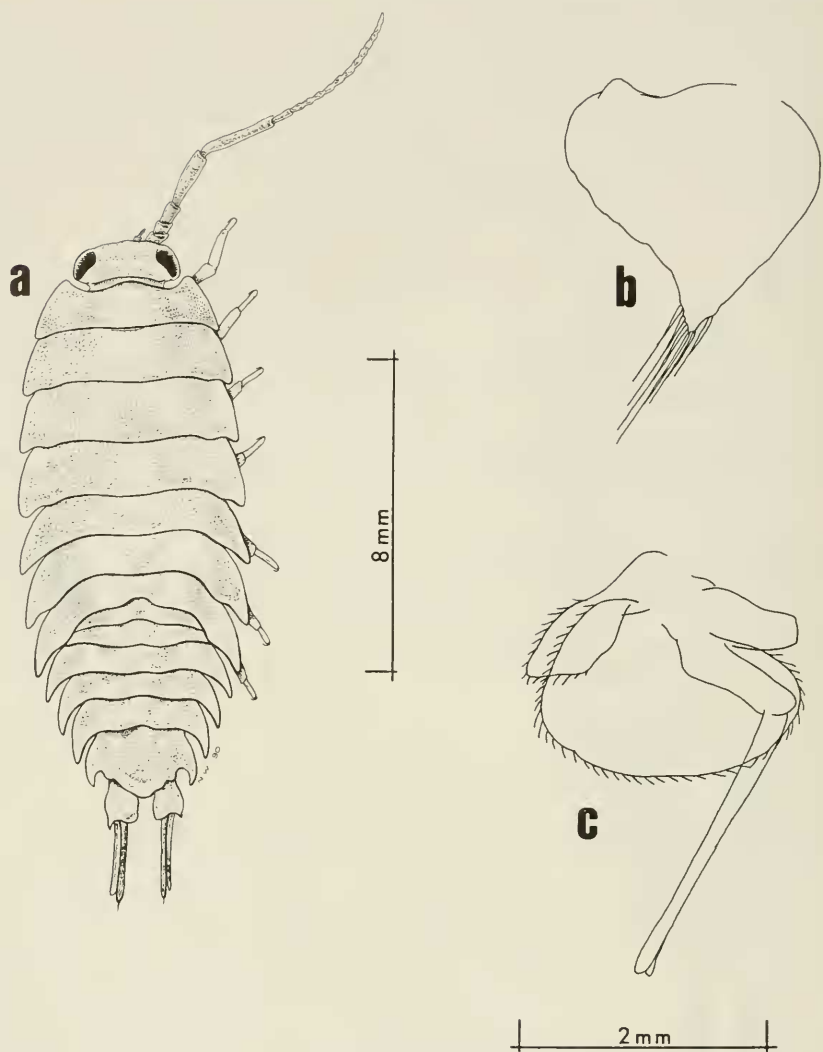


FIGURE 3. *Ligia pallasii*: male specimen, a, dorsal view; b, exopod, right male pleopod 1; c, right male pleopod 2. Original drawings by Nancy Walker from CASIZ 075488.

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|--|----------------------------------|--|--|
| 16b. Surface of body tuberculate. Posterolateral margin of pereonite one manifestly produced posteriorly | 17 | uropods minute and inserted near inner margin of basal article (Fig. 20) | |
| 17a. Telson spatulate, rounded (Fig. 16) | | 19. <i>Venezillo microphthalmus</i> | |
| 15. <i>Porcellio dilatatus</i> | | | |
| 17b. Telson pointed (Fig. 15) | | | |
| 14. <i>Porcellio scaber</i> | | | |
| 18a. Eyes with many more than 4 ommatidia. Telson trapezoidal. Exopods of uropods large (Fig. 19) | 18. <i>Armadillidium vulgare</i> | | |
| 18b. Eyes composed of about 4 ommatidia. Telson hourglass shaped. Exopods of | | | |

SPECIES ACCOUNTS

1. *Ligia occidentalis* Dana, 1853 (Fig. 2)

Ligia occidentalis is commonly encountered in rocky littoral habitats in sheltered and open coast environments along the California coast from Sonoma County to the Gulf of California (Ricketts and Calvin 1968; Garthwaite et al. 1985).

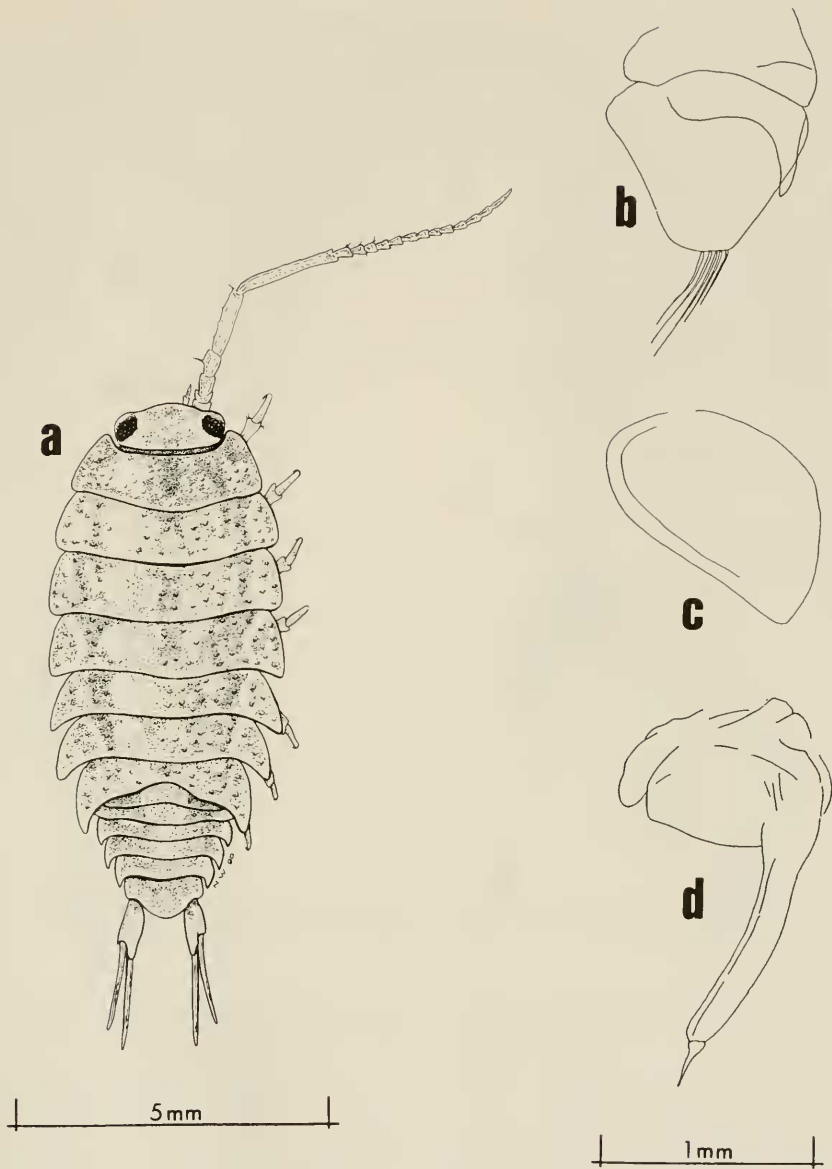


FIGURE 4. *Ligidium latum*: a, dorsal view; b, exopod, right male pleopod 1; c, exopod, right male pleopod 2; d, endopod, right male pleopod 2. Original drawings by Nancy Walker from CASIZ 075498.

This species was originally described from the San Francisco Bay Area on the basis of specimens taken from the Sacramento River (Dana 1853). Although the area covered in our survey stopped at the Verazano Straights, Ricketts and Calvin (1968) stated that *L. occidentalis* occurs on the shores of the Sacramento River. In the Bay Area, Richardson (1904) reported this spe-

cies from Sausalito (Marin County), and Miller (1938) collected it at Moss Beach and Montara (San Mateo County) and stated that it was widely distributed throughout the San Francisco Bay region. We found *L. occidentalis* to be very common and widely distributed in the Bay Area, predominantly along rocky shores both within the bay and along the open coast.

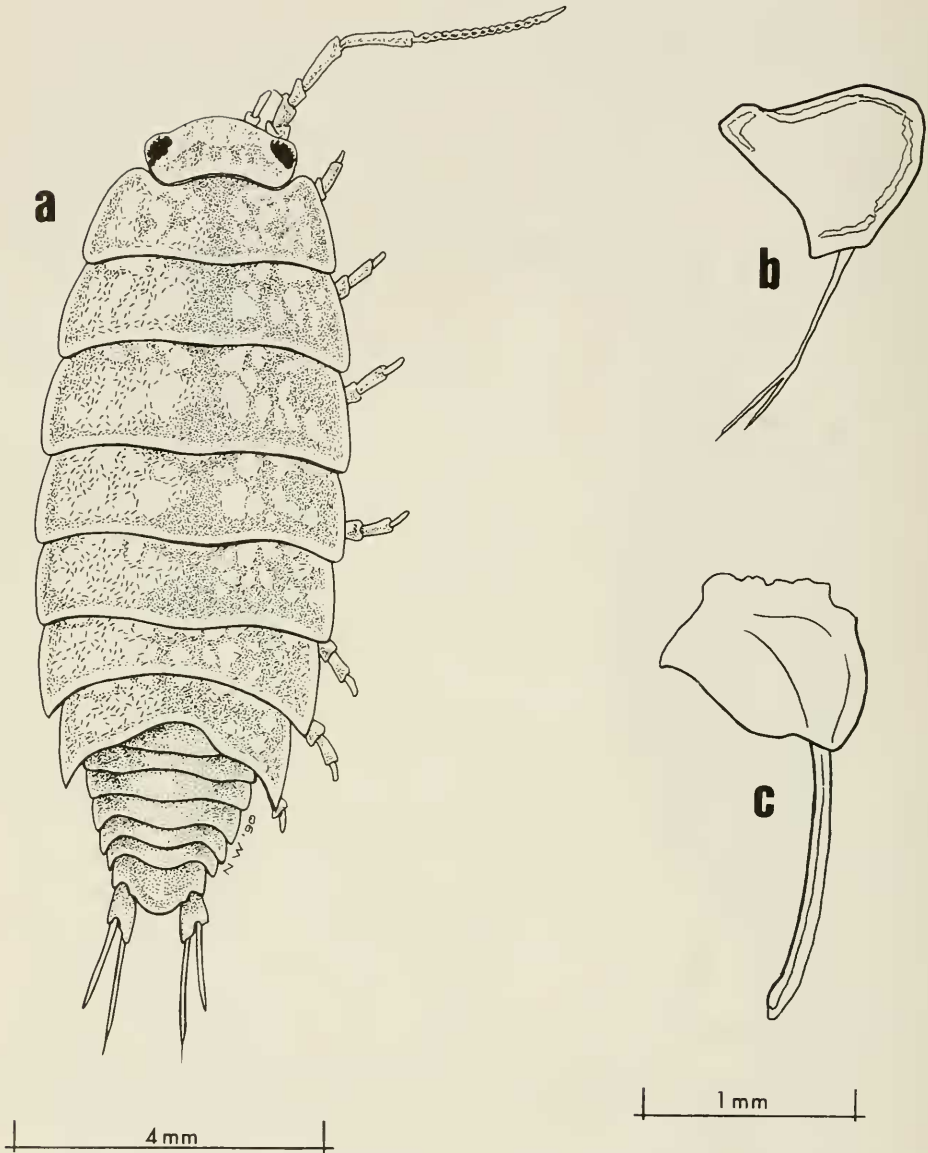


FIGURE 5. *Ligidium gracile*: a, dorsal view; b, exopod, right male pleopod 1; c, right male pleopod 2. Original drawings by Nancy Walker from CASIZ 075490.

2. *Ligia pallasii* Brandt, 1833

(Fig. 3)

Another littoral species found in rocky habitats, *L. pallasii* occurs from Santa Cruz, Santa Cruz County, California to Alaska (Ricketts and Calvin 1968; Garthwaite, unpubl.), but appears to be restricted to open coast environments. In the Bay Area, Miller (1938) collected this species

on the outer coast at Montara, San Mateo County. In this survey, we collected *L. pallasii* from rocky habitats at two localities (sites 1 and 33, Fig. 1) on the outer coast.

3. *Ligidium latum* Jackson, 1923

(Fig. 4)

Ligidium latum, a riparian species originally described from San Francisco (Jackson 1923), is

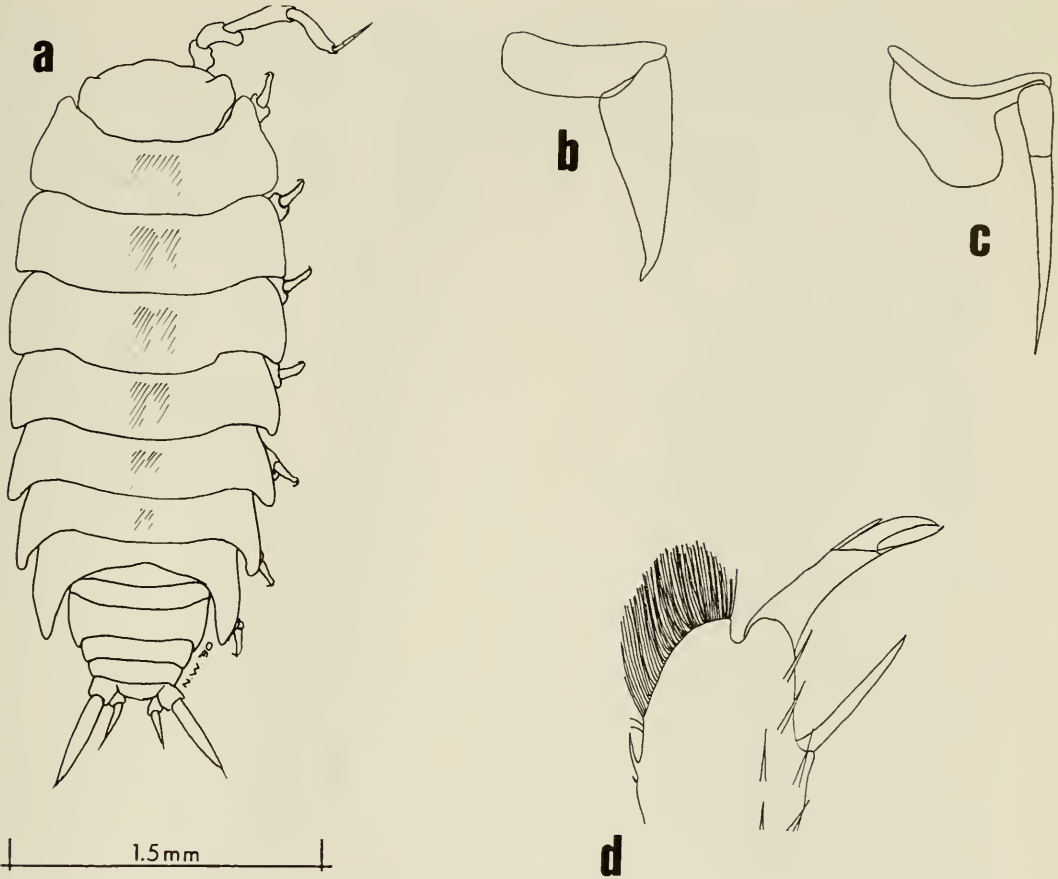


FIGURE 6. *Protrichoniscus heroldi*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075423); b, right male pleopod 1; c, right male pleopod 2; d, distal segment of male pereopod 7 (b–d adapted from Arcangeli 1932, magnifications not provided).

widely distributed in California but infrequently collected. Outside the San Francisco Bay Area, we have collected it at Refugio Creek, Santa Barbara County (Garthwaite et al. 1985) and at three sites in Santa Cruz County (Swanton, 10 May 1986; Bonny Doon, 29 May 1986; and Henry Cowell Redwoods State Park, 10 May 1986). Within the Bay Area, *L. latum* has been collected from Mission Peak, Alameda County (Van Name 1940). In this survey, we collected *L. latum* at sites 162 and 163 only.

4. *Ligidium gracile* (Dana, 1856)
(Fig. 5)

Ligidium gracile, another riparian species, is widely distributed in California. The Santa Barbara Museum of Natural History has specimens of this species collected on Tranquillon Moun-

tain, Vandenberg Air Force Base, Santa Barbara County, and it has been reported from Eureka and Richardson Grove State Park, Humboldt County (as *Ligidium gracilis*; Miller 1938). Outside of the San Francisco Bay Area, we have collected this species at several sites in Santa Cruz County (Swanton, 10 May 1986; Bonny Doon, 29 May 1986; Henry Cowell Redwoods State Park, 10 May 1986; and Forest of Nisene Marks State Park, 10 May 1986) and two sites in Sonoma County (Shell Beach at Sea Ranch, 1 June 1986; Stump Beach, 1 June 1986). In the Bay Area, this species has been reported from San Francisco, San Francisco County (as *Ligidium hypnorum* (Cuvier, 1792), a European species; Stuxberg 1875); Santa Clara, Santa Clara County (Jackson 1923); Angel Island, Marin County (Van Name 1936); Berkeley, Alameda County (as *L. gracilis*; Miller 1938); and Moss

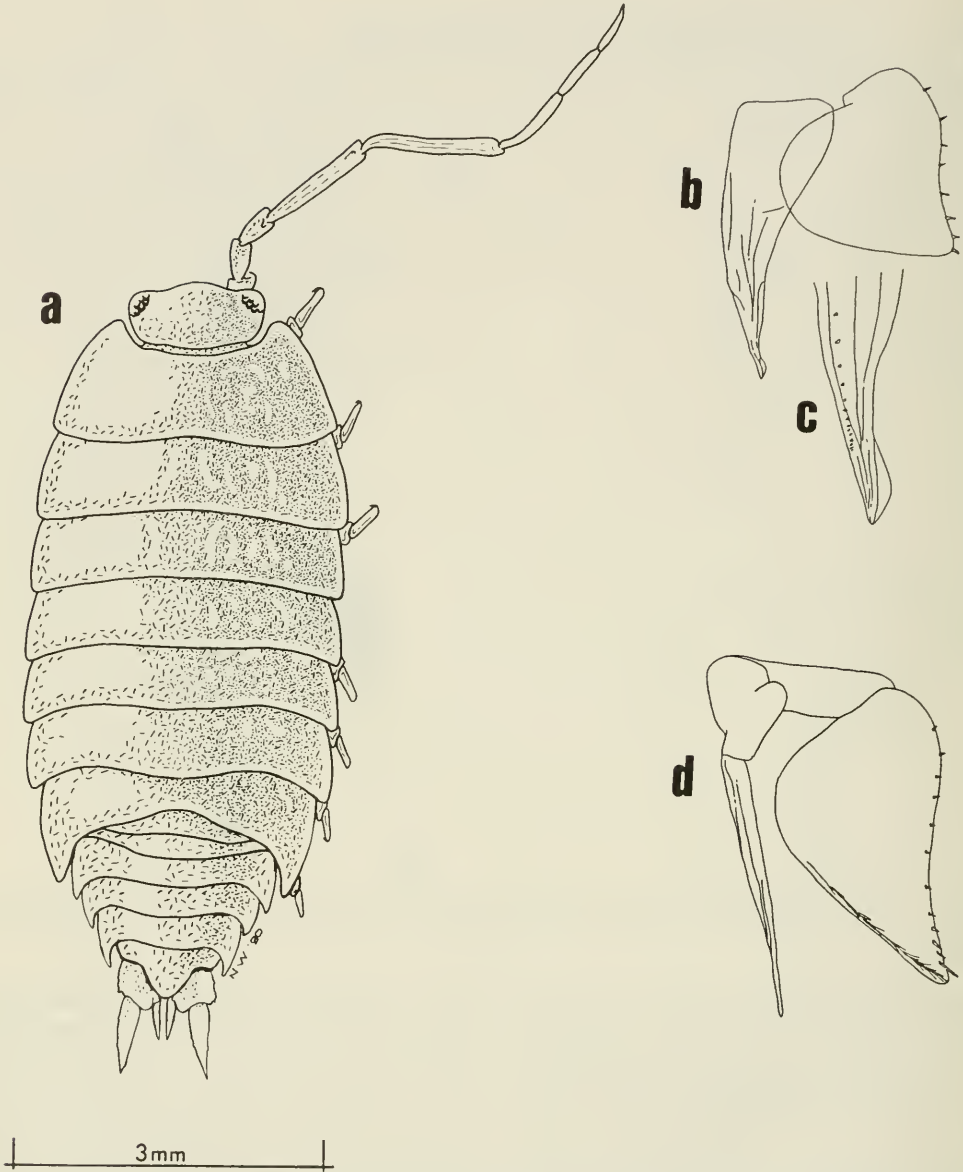


FIGURE 7. *Littorophiloscia richardsonae*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075421); b, left male pleopod 1; c, enlargement of tip of endopod of male pleopod 1; d, left male pleopod 2 (b–d adapted from Taiti and Ferrara 1986, magnifications not provided).

Beach, San Mateo County (as *L. gracilis*; Miller 1938). We collected *L. gracile* only at Muir Beach (site 163; Table 2, Fig. 1).

5. *Protrichoniscus heroldi* Arcangeli, 1932 (Fig. 6)

Protrichoniscus heroldi was originally described from specimens collected at San Mateo, San Mateo County, and Muir Woods, Marin

County (Arcangeli 1932). Although uncommon, this species is widely distributed in California, having been collected in Calaveras, Tulare, and Santa Cruz counties (Mulaik and Mulaik 1943) and in Riverside and San Bernadino counties (Garthwaite et al. 1985). One of us (RLG) has collected this species from Cave Gulch, near Santa Cruz, Santa Cruz County (1 August 1986) and at Drytown, Amador County (2 November 1986).

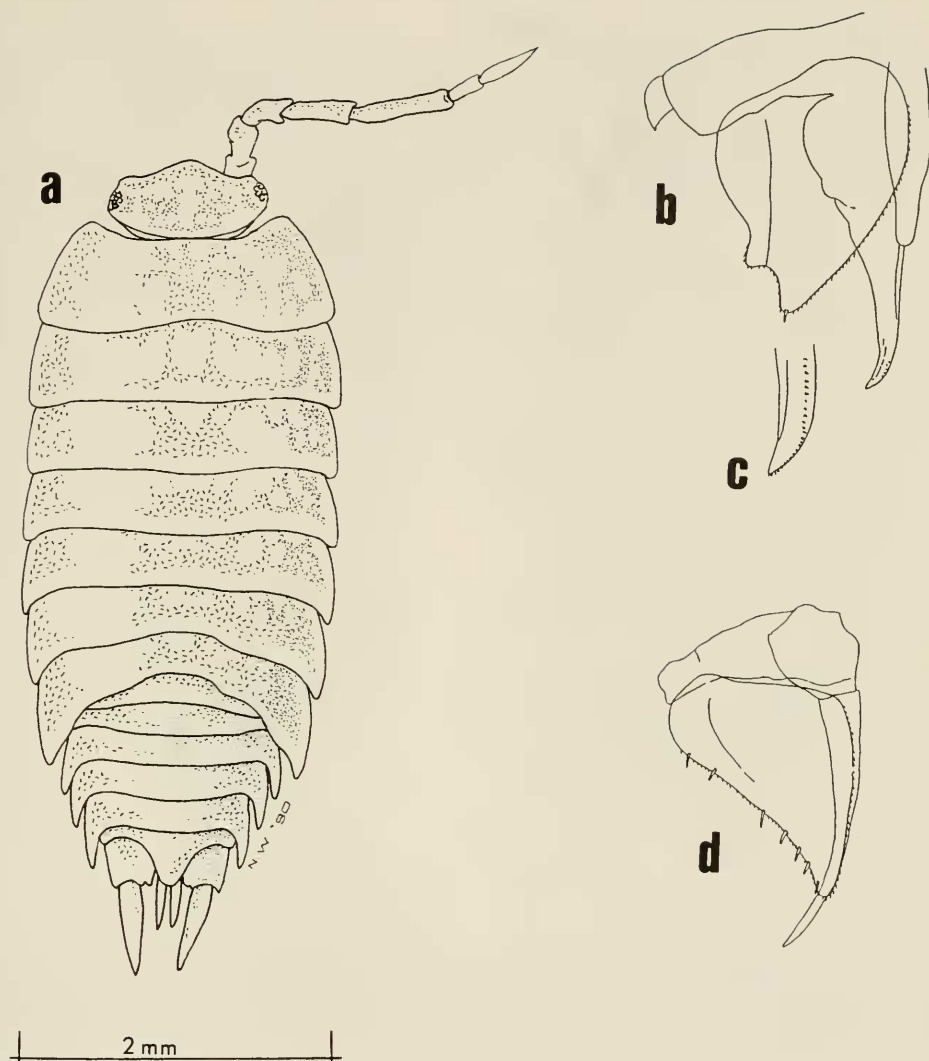


FIGURE 8. *Mauritaniscus littorinus*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075327); b, right male pleopod 1; c, enlargement of tip of endopod of male pleopod 1; d, right male pleopod 2 (b–d adapted from Schultz et al. 1982, magnifications not provided).

We collected *P. heroldi* at Muir Woods (site 159) and Point Pinole (sites 110 and 114; Table 2, Fig. 1).

6. *Littorophiloscia richardsonae* (Holmes and Gay, 1909)
(Fig. 7)

Littorophiloscia richardsonae is a common Pacific Coast littoral species, found in marshes, along bays and estuaries, and on the outer coast from Baja California, Mexico to Washington (Garth-

waite et al. 1985). In the San Francisco Bay Area, Miller (1938) collected this species (which he referred to as *Philoscia richardsonae*) at Alameda, Alameda County. In this survey, we found *L. richardsonae* to be a common species throughout the Bay Area.

7. *Mauritaniscus littorinus* (Miller, 1936)
(Fig. 8)

Mauritaniscus littorinus has had a complex taxonomic history, and the true identity of this taxon remains in doubt. Miller described it as a

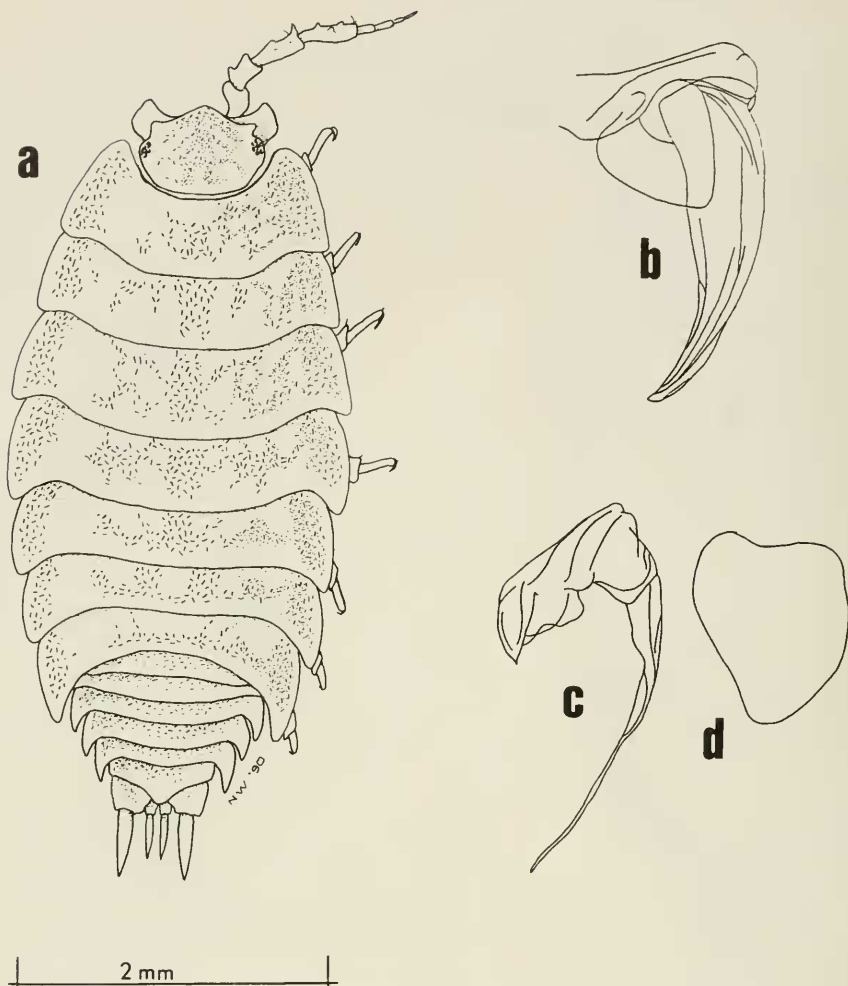


FIGURE 9. *Detonella papillicornis*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075449); b, right male pleopod 1; c, endopod of right male pleopod 2; d, exopod of right male pleopod 2 (b-d adapted from Lohmander 1927, magnifications not provided).

new species, *Porcellio littorina* Miller, 1936, on the basis of specimens he collected in the San Francisco Bay Area on Bay Farm Island, Alameda County. Schultz et al. (1982) later transferred this species to the genus *Mauritaniscus*. Ferrara and Taiti (1989), however, assert without supporting data that this species is synonymous with *Niambia capensis*, an African oniscid first described from South Africa as *Metoponorthus capensis* (Dollfus, 1895). Until a more complete comparison of *M. littorinus* and *N. capensis* is published, we retain the name *M. littorinus* for this species. *Mauritaniscus littorinus* has been found along the California coast from San Francisco Bay to San Diego, San Diego County

(Schultz et al. 1982). The specimen of *M. littorinus* reported from Bay Center, Pacific County, Washington by Hatch (1939) as *P. littorina* was actually an immature specimen of *P. scaber* (see Hatch 1947). We found *M. littorinus* to be common and widely distributed in littoral sites throughout the Bay Area.

8. *Detonella papillicornis* (Richardson, 1904) (Fig. 9)

This littoral species was originally described from Alaska (Richardson 1904) and has only recently been reported from California (Garthwaite 1988). In the area included in this survey, we collected *D. papillicornis* at Bolinas Lagoon,

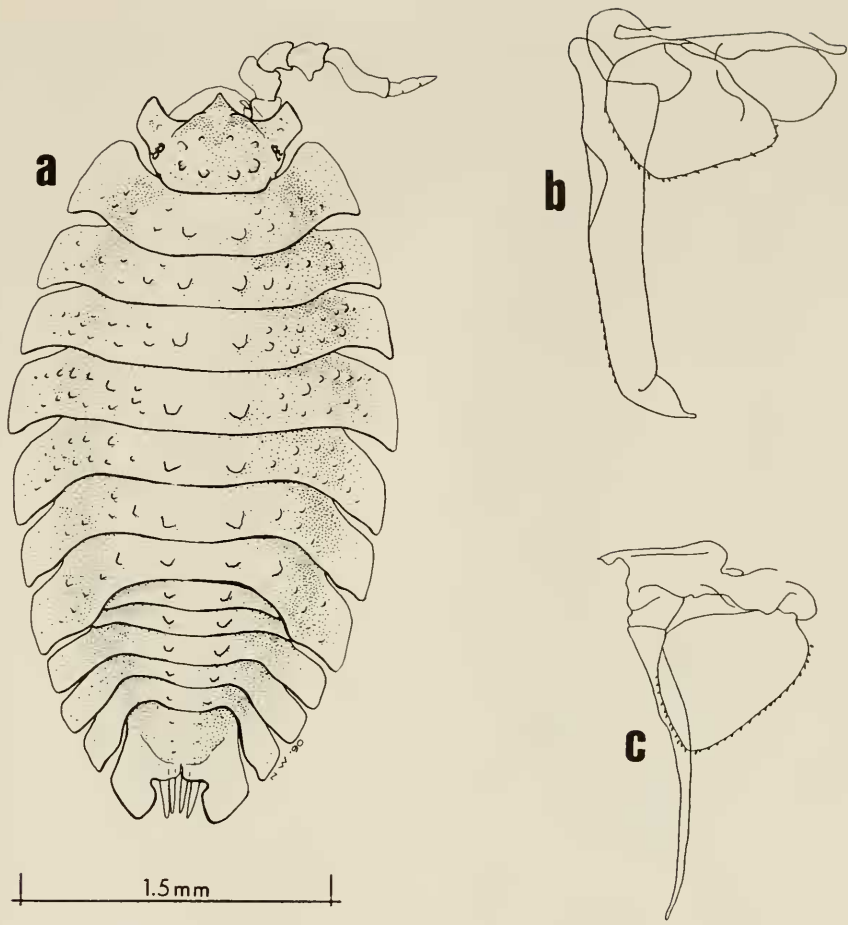


FIGURE 10. *Armadilloniscus coronacapitalis*: female specimen, a, dorsal view (original drawing by Nancy Walker from CASIZ 075392); b, left male pleopod 1; c, left male pleopod 2 (b, c adapted from Menzies 1950, magnifications not provided).

Marin County, and in littoral sites throughout San Francisco Bay, where it is rather common.

9. *Armadilloniscus coronacapitalis* Menzies, 1950 (Fig. 10)

Armadilloniscus coronacapitalis was originally described from Tomales Bay, Marin County, California (Menzies 1950) and was recently reported from San Miguel and Anacapa islands, California (Garthwaite et al. 1985). In the San Francisco Bay Area, this littoral species has previously been reported from Bolinas Lagoon, Marin County (Garthwaite 1988). We found it

to be common and widespread in littoral habitats throughout San Francisco Bay.

10. *Armadilloniscus lindahli* (Richardson, 1905) (Fig. 11)

This species has been collected from littoral habitats from Baja California, Mexico to Marin County, California (Garthwaite et al. 1985; Garthwaite 1988). In the San Francisco Bay Area, Richardson (1905) reported it from Oakland, Alameda County (as *Actoniscus lindahli*) and Miller (1938) reported it from Bay Farm Island, Alameda County (as *Actoniscus lindahli*). In this survey we found *Armadilloniscus lindahli* in large numbers at Bolinas Lagoon, Marin County, and in littoral sites throughout San Francisco Bay, although in the Bay it is nowhere very common.

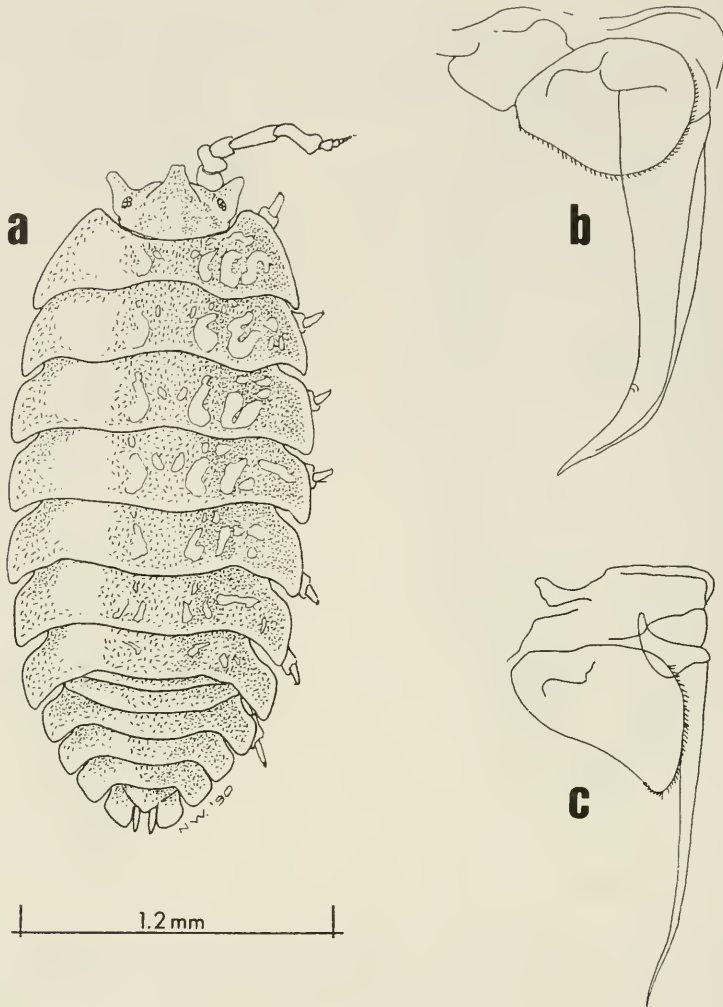


FIGURE 11. *Armadilloniscus lindahli*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075317); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Menzies 1950, magnifications not provided).

11. *Armadilloniscus holmesi* Arcangeli, 1933
(Fig. 12)

Armadilloniscus holmesi is common along the Pacific Coast and can be found in marshes, bays, and estuaries from Washington to Baja California, Mexico (Garthwaite et al. 1985). In the San Francisco Bay Area Miller (1938) reported it from Bay Farm Island, Alameda County (as *Actoniscus tuberculatus* [Holmes and Gay, 1909]). We found *A. holmesi* to be very common and widely distributed throughout San Francisco Bay and present but less common at Bolinas Lagoon.

12. *Alloniscus perconvexus* Dana, 1856
(Fig. 13)

This species occurs from southern California to Washington on sandy beaches where it burrows into the sand under detritus at approximately the high tide line (Garthwaite et al. 1985). In the San Francisco Bay Area, Arcangeli (1932) reported it from San Mateo, San Mateo County, and Miller (1938) collected it at Moss Beach, San Mateo County. In this survey, we found *A. perconvexus* at Fort Funston (sites 22 and 23) along the open coast and at Point Pinol (site 113) within the bay (Table 2, Fig. 1).

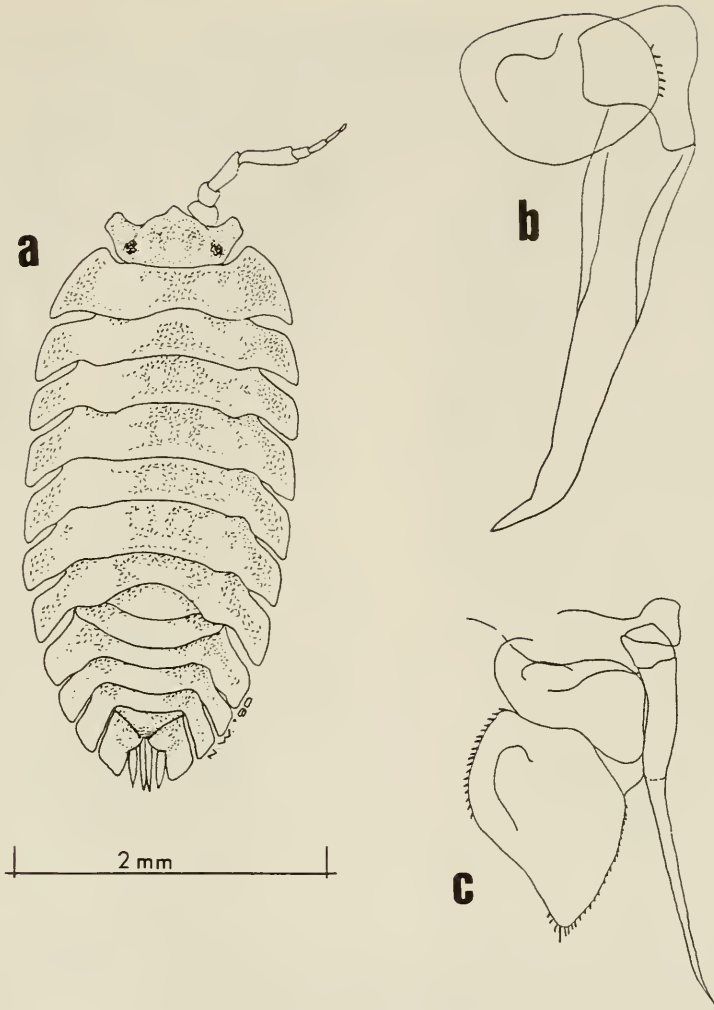


FIGURE 12. *Armadilloniscus holmes*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075412); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Menzies 1950, magnifications not provided).

13. *Alloniscus mirabilis* (Stuxberg, 1875)
(Fig. 14)

Alloniscus mirabilis has rarely been collected but is widely distributed in California, having been found in San Diego County, Orange County, San Luis Obispo County, San Mateo County, and on the California Channel Islands (Garthwaite et al. 1985). Although we have not found this species in the area included in this survey, we have included it here because it has been found at localities nearby (Pebble Beach, San Mateo County; Garthwaite et al. 1985), and there

is no reason why it should not be present in the Bay Area.

14. *Porcellio scaber* Latreille, 1804
(Fig. 15)

Although this species is of European origin, it is common throughout most of the United States and is one of the most common oniscids of the Pacific Coast (Garthwaite, unpubl.). In the San Francisco Bay Area it was reported by Stuxberg (1875) from San Francisco, San Francisco County and Sausalito, Marin County; and by Arcan-geli (1932) from San Mateo, San Mateo County.

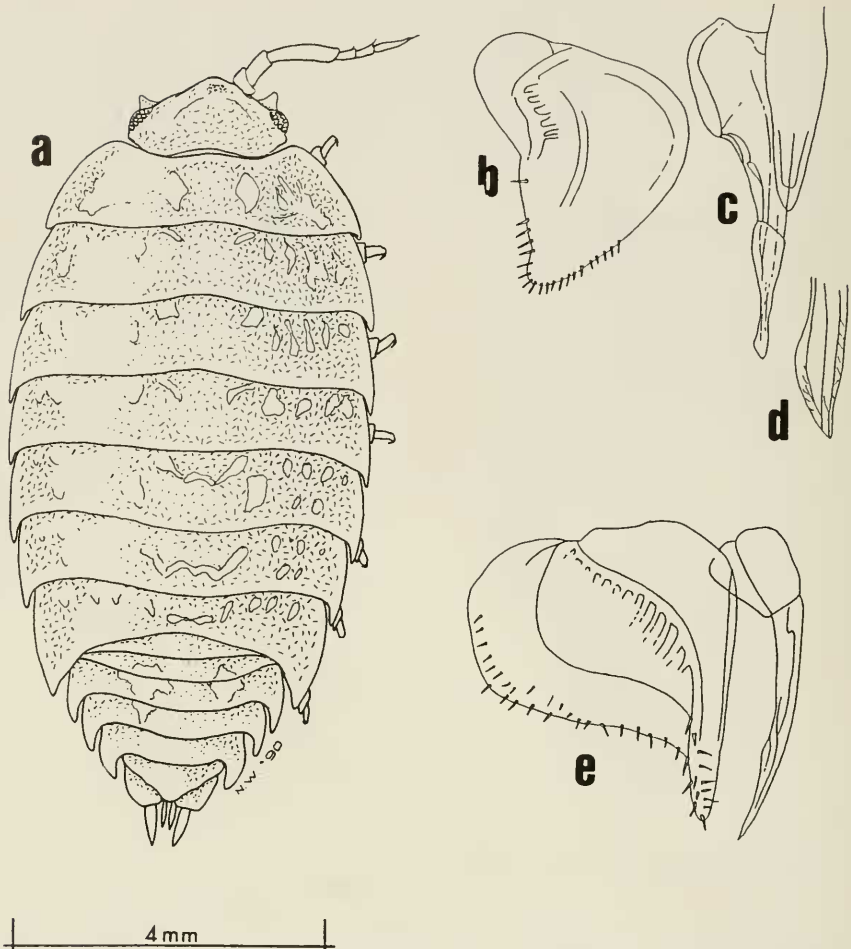


FIGURE 13. *Alloniscus perconvexus*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075425); b, exopod of right male pleopod 1; c, endopod of right male pleopod 1; d, enlargement of tip of endopod of right male pleopod 1; e, right male pleopod 2 (b–e adapted from Schultz 1984, magnifications not provided).

Miller (1938), who collected it at Oakland and Berkeley, Alameda County and Moss Beach, San Mateo County, reported it as widely distributed in the San Francisco Bay Area (Miller 1936). We have found this species to be the only truly terrestrial isopod established in the Farallon Islands where it is common on South Farallon. We found *P. scaber* common throughout the Bay Area.

15. *Porcellio dilatatus* Brandt and Ratzeburg, 1833
(Fig. 16)

Like *Porcellio scaber*, *P. dilatatus* is a European introduction that has become widely distributed throughout the Pacific states. Miller (1936), who

listed it as *Porcellio spinicornis* Say, 1818, reported it as widely distributed in the San Francisco Bay Area and collected it at Berkeley, Alameda County, and Moss Beach, San Mateo County (Miller 1938). We found *P. dilatatus* widely distributed and moderately common throughout the Bay Area.

16. *Porcellio laevis* Latreille, 1804
(Fig. 17)

Another widely distributed European species, *P. laevis* was first reported from the San Francisco Bay Area by Stuxberg (1875) who mistakenly described it as a new species, *Porcellio formosus*, from San Francisco, San Francisco County. Arcangeli (1932) redescribed *P. for-*

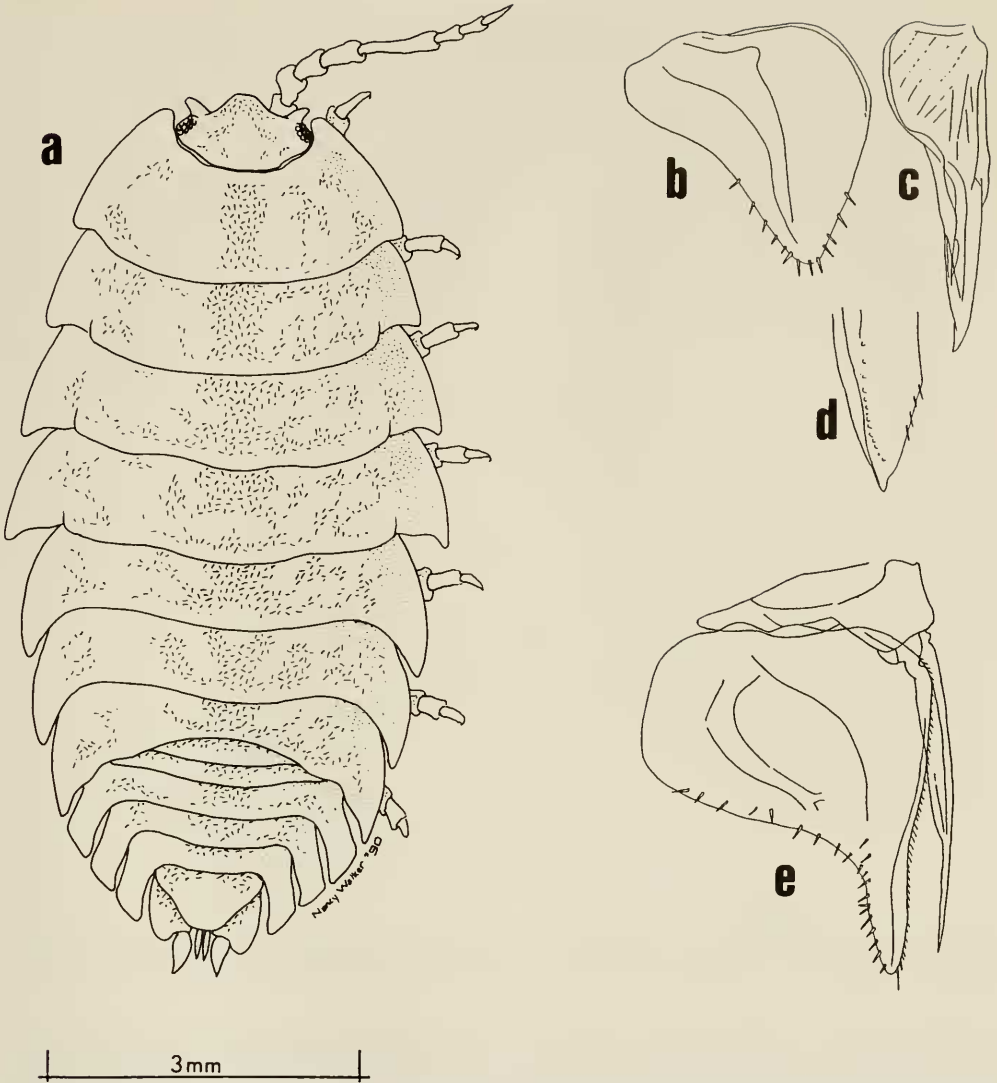


FIGURE 14. *Alloniscus mirabilis*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075422); b, exopod of right male pleopod 1; c, endopod of right male pleopod 1; d, enlargement of tip of endopod of right male pleopod 1; e, right male pleopod 2 (b–e adapted from Schultz 1984, magnifications not provided).

mosus (on the basis of specimens from Louisiana and Texas). Thus, Miller (1936) thought the species valid. However, Van Name (1940) states that the specimens described by Arcangeli were apparently *Porcellionides virgatus* (Budde-Lund, 1885). Miller (1936) found *P. laevis* to be widely distributed throughout the San Francisco Bay Area and collected it at Berkeley and Oakland (Alameda County), and Moss Beach (San Mateo County). We also found *P. laevis* common and widely distributed throughout the Bay Area.

17. *Porcellionides floria* Garthwaite and Sassaman, 1985
(Fig. 18)

In North America, this European introduction is morphologically very similar to *Porcellionides pruinosus* (Brandt, 1833) which is also from Europe (Garthwaite and Sassaman 1985). Although it is impossible to assign individuals of these two taxa definitively to species without fresh specimens (see Garthwaite and Sassaman 1985), all

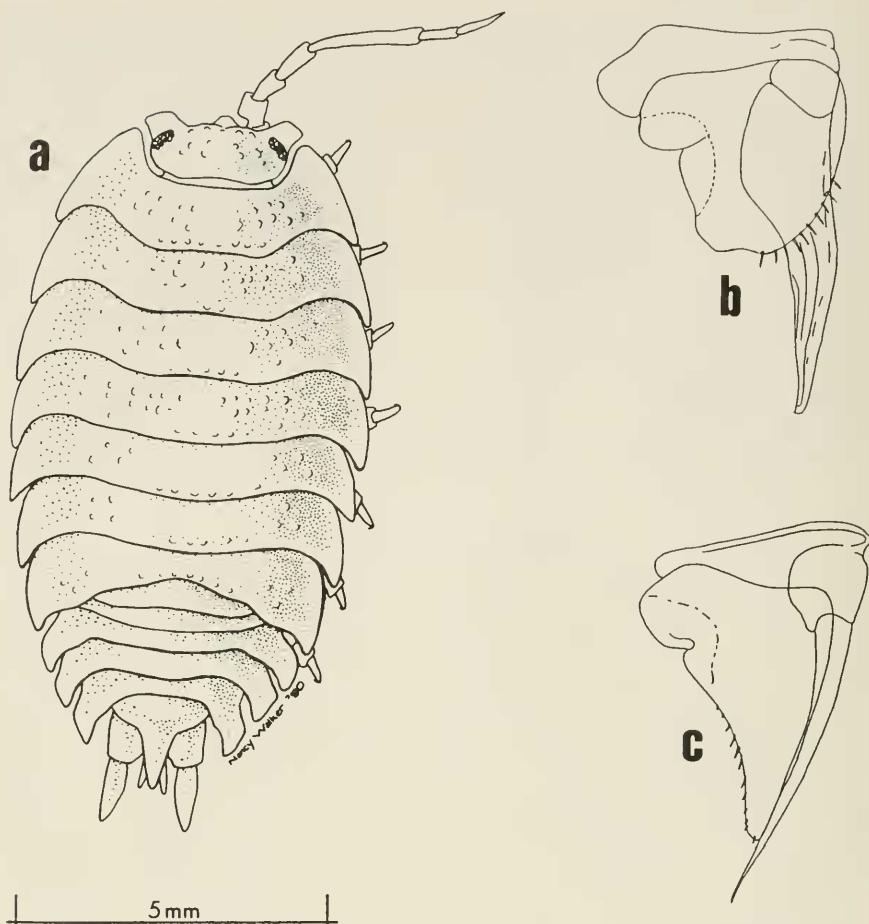


FIGURE 15. *Porcellio scaber*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075527); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Wachtler 1937, magnifications not provided).

recent collections of *Porcellionides* from California have been *P. floria* with the exception of a single collection of *P. pruinosus* from Death Valley, Inyo County (Garthwaite and Sassaman 1985). On this basis we assume all previous reports of *P. pruinosus* from the San Francisco Bay Area to be *P. floria*. In the Bay Area, *P. floria* was reported by Stuxberg (1875) (as *Porcellio maculicornis* Koch, 1835–44) from San Francisco, San Francisco County. Miller (1938), who listed it as *Metaponorthus pruinosus* (Brandt, 1833) collected this species at Berkeley and Oakland (Alameda County), and Mount Diablo (Contra Costa County). We collected *P. floria* at only four localities: Rodeo (site 115), San Rafael (site 154), East Brothers Island (site 107) and on Stanford University campus (site 52, Table 2, Fig. 1).

18. *Armadillidium vulgare* (Latreille, 1804) (Fig. 19)

Armadillidium vulgare is another European introduction that is widely distributed and very common throughout California and most of North America. In the San Francisco Bay Area, it has been reported by Essig (1926) from "the San Francisco Region," by Arcangeli (1932) from San Mateo, San Mateo County (as *Armadillidium cinereum* [Zenker, 1793]), and by Miller (1938), who collected it in Berkeley, Oakland, and Alameda (Alameda County), and Moss Beach (San Mateo County). We found *A. vulgare* very common and widely distributed throughout the Bay Area.

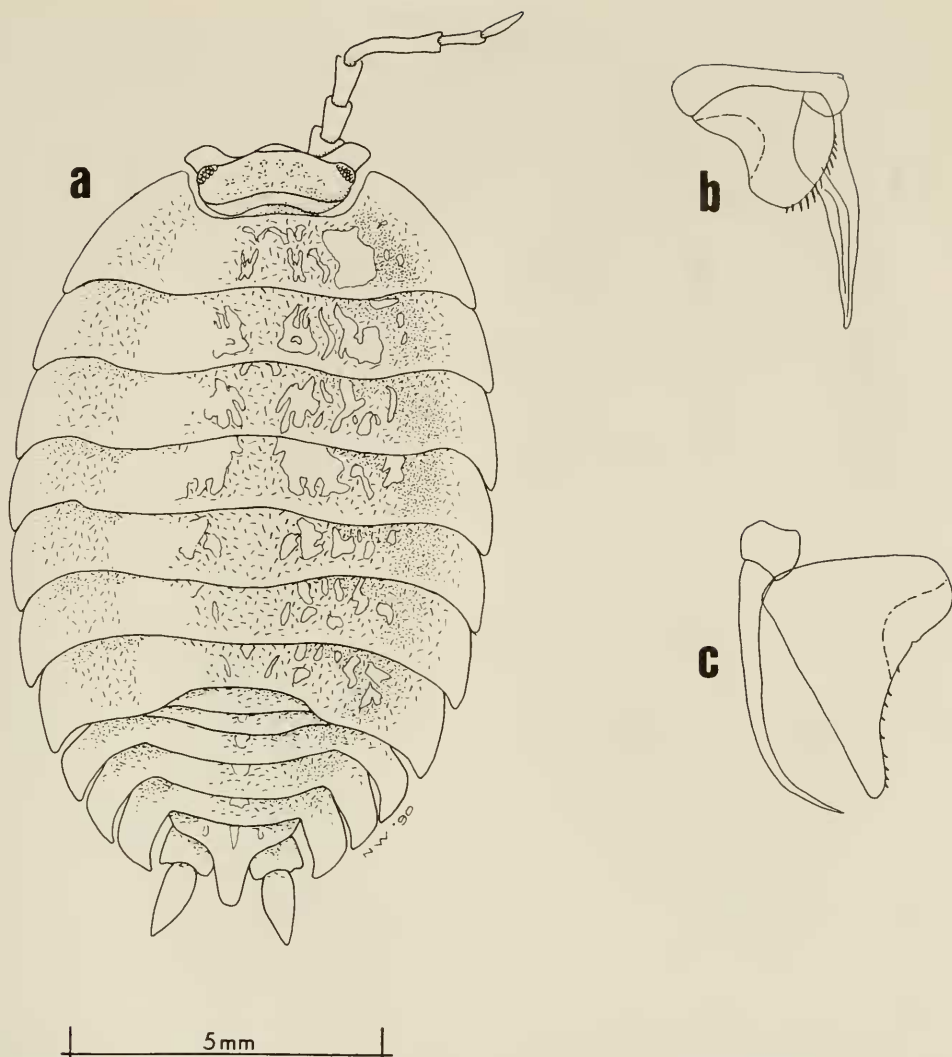


FIGURE 16. *Porcellio dilatatus*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075509); b, right male pleopod 1; c, right male pleopod 2 (b adapted from Wachtler, 1937, magnifications not provided; c adapted from Edney 1953, magnifications not provided).

19. *Venezillo microphthalmus* (Arcangeli, 1932)
(Fig. 20)

This species was first described (as *Armadillo microphthalmus*) on the basis of specimens collected in the San Francisco Bay Area at Saratoga, Santa Clara County (Arcangeli 1932). Although it was later collected at several localities in Tulare and Calaveras counties in California (Mulaik and Mulaik 1942), it has never again been collected in the Bay Area, and the only recent collections made of this species have been from the Channel Islands of southern California (Garthwaite et al.

1985). We did not encounter *V. microphthalmus* in our survey, but we have deposited specimens of this species from Santa Barbara Island (collected 24 January 1984) in the California Academy of Sciences for reference (catalog No. CASIZ 075538).

DISCUSSION

Although there have been several significant changes in the known distribution of oniscid isopods in the San Francisco Bay Area since Miller's (1938) summary, the distribution and relative

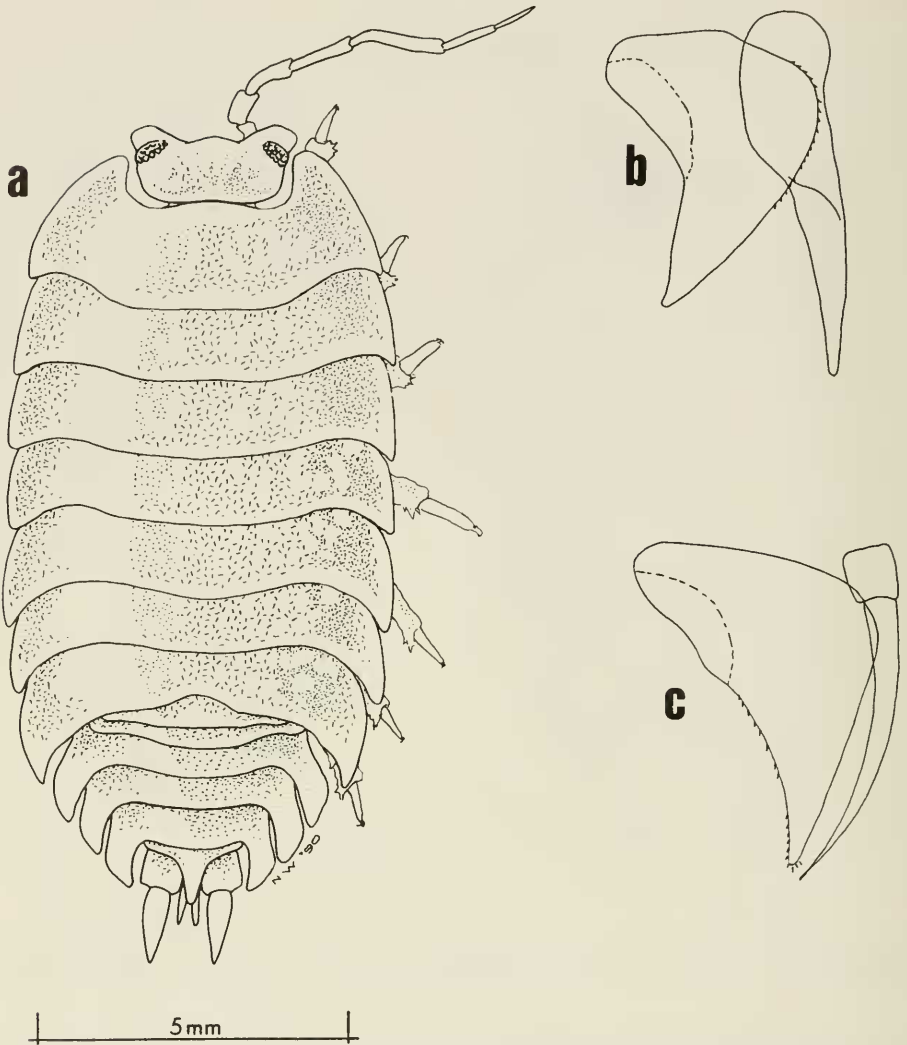


FIGURE 17. *Porcellio laevis*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075336); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Edney 1953, magnifications not provided).

abundance of most species appear to have remained about the same. Taking into account nomenclatural changes and mistaken identifications, and disregarding *Cubaris californica* (Budde-Lund, 1885) (which was so poorly described that it could not be recognized again if found and for which no types appear to exist), Table 2 lists the oniscid isopods collected in the present survey and those previously reported from the Bay Area.

In this survey, we found the non-littoral oniscid fauna of the San Francisco Bay Area to be dominated, in general, by four introduced species of European origin. *Armadillidium vulgare* was

by far the most common non-littoral species encountered, found at 61 of the 176 sites surveyed (Table 2). Next in abundance were *Porcellio scaber* (found at 54 sites), *P. dilatatus* (34 sites), and *P. laevis* (22 sites) (Table 2). The native California non-littoral oniscids were much rarer. We found *Protrichoniscus heroldi* at only three sites, *Ligidium latum* at two sites, *L. gracile* at one site, and *Venezillo microphthalmus* was not encountered at all. The introduced species *Porcellionides floria* was also found to be rare in the Bay Area (found at only four sites). Our results for non-littoral isopods are similar to those of Miller (1936, 1938) who also found *A. vulgare*,

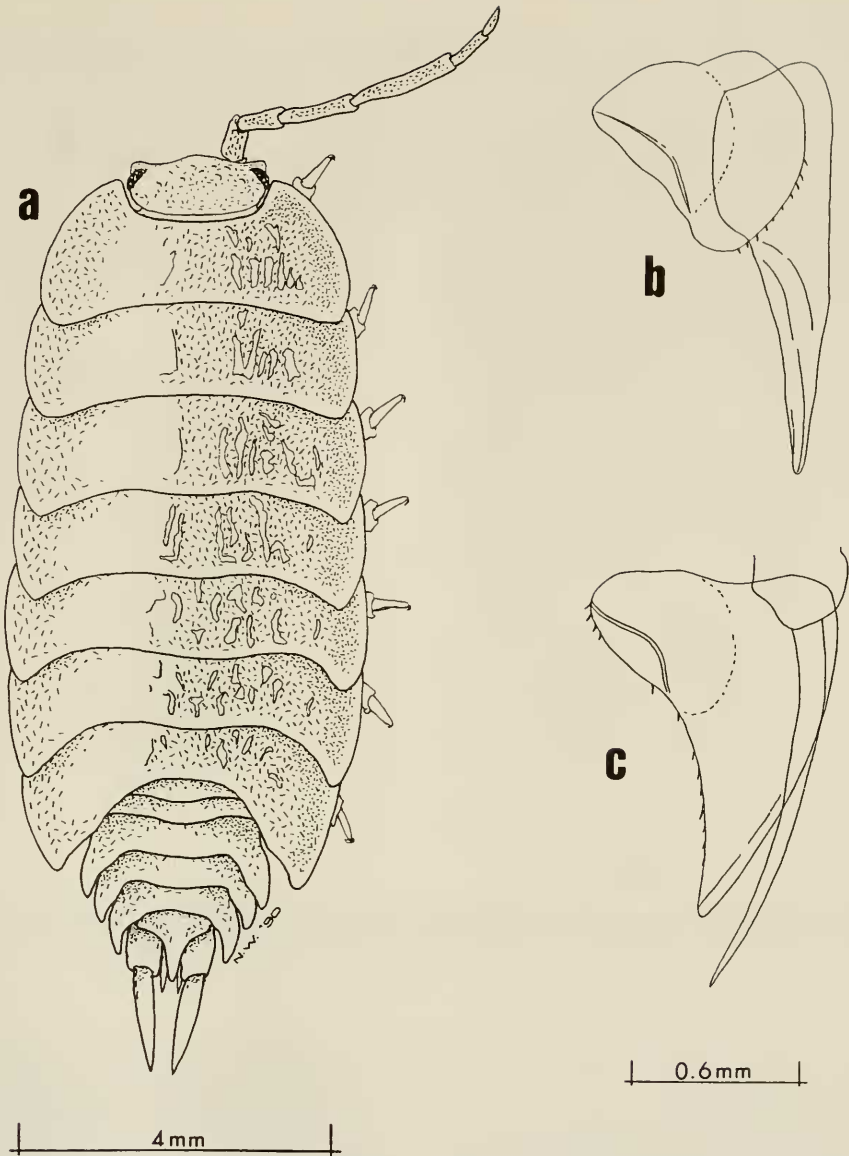


FIGURE 18. *Porcellionides floria*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075424); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Gruner 1966, as *Metoponorthus pruinosus*).

Porcellio scaber, *Porcellio dilatatus*, and *Porcellio laevis* to all be widely distributed in the Bay Area (whereas he did not collect *Protrichoniscus heroldi*, *Ligidium latum*, or *Venezillo microphthalmus*). Miller (1938) collected *Ligidium gracile* and *Porcellionides floria* from three sites each in the Bay Area.

Of the littoral oniscids, *Ligia occidentalis* was the most commonly encountered (found at 27 sites). However, this species was closely followed

in abundance by a number of other littoral species including *Armadilloniscus coronacapitalis* (25 sites), *Mauritaniscus littorinus* (22 sites), *Littorophiloscia richardsonae* (20 sites), and *Armadilloniscus holmesi* (19 sites), while *Detonella papillicornis*, *Armadilloniscus lindahli*, *Alloniscus perconvexus*, and *Ligia pallasii* were found at 15 sites, 11 sites, three sites, and two sites respectively (Table 2). Miller (1938) also found *Ligia occidentalis* to be the most common littoral

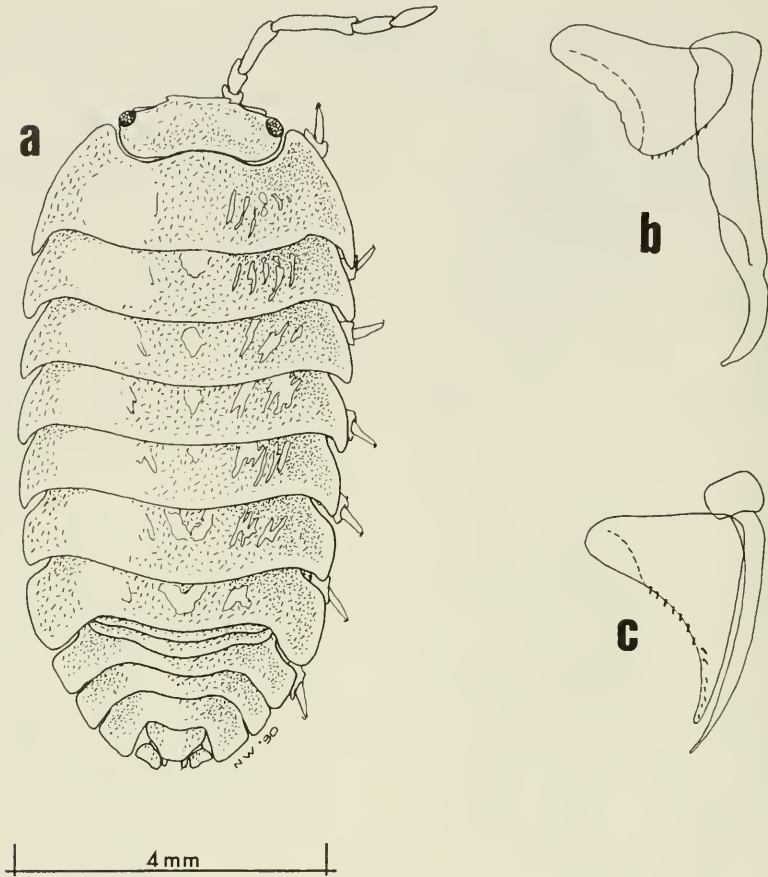


FIGURE 19. *Armadillidium vulgare*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075526); b, right male pleopod 1; c, right male pleopod 2 (b, c adapted from Edney 1953, magnifications not provided).

species in the Bay Area, whereas the other littoral species that he encountered he collected from only a single locality each.

Conspicuously absent from Miller's list are *Armadilloniscus coronacapitalis* and *Detonella papillicornis*. *A. coronacapitalis* was first reported from Tomales Bay, Marin County, California by Menzies (1950). Since this description it has been found in Bolinas Lagoon, Marin County (Garthwaite 1988) and on the Channel Islands of southern California (Garthwaite et al. 1985). We found it to be widely distributed throughout San Francisco Bay, where it was the second most commonly encountered littoral species (found at 25 sites). Although *A. coronacapitalis* has apparently not been reported from elsewhere in the world, its late discovery and apparent rapid expansion into new areas are characteristic of in-

troduced species. If Miller's (1938) list is an accurate indication of the oniscids of San Francisco Bay at that time, then the possibility exists that *A. coronacapitalis* is not native to California. However, in the absence of more direct evidence and because it is present on the California Channel Islands we consider it to be native.

Similarly, if previous reports on San Francisco Bay oniscids have been accurate, then *Detonella papillicornis* appears to have been recently established in the Bay Area as well. Although this species was present in the first collections of oniscids from Alaska (Richardson 1904), it has only recently been reported from sites in California. Taiti (personal communication) collected it from Tomales Bay, Marin County, and Garthwaite (1988) reported it from Bolinas Lagoon, Marin County. In this survey, we found *D. papillicornis*

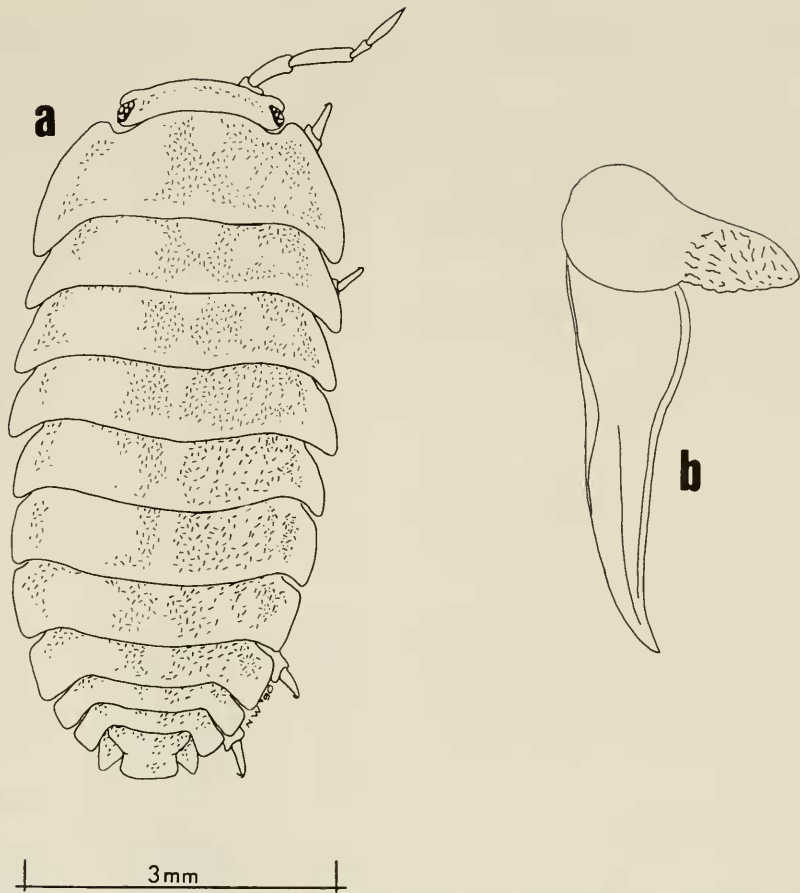


FIGURE 20. *Venezillo microphthalmus*: a, dorsal view (original drawing by Nancy Walker from CASIZ 075538); b, left male pleopod 1 (adapted from Arcangeli 1932, magnifications not provided).

to be widely distributed and moderately common in San Francisco Bay (found at 15 sites).

Although Miller (1936) was the first to report *Mauritaniscus littorinus* from California, he found it at only a single locality in San Francisco Bay (Bay Farm Island, Alameda County). If Miller's report is an accurate indication of oniscid distributions at the time then this species has undergone a remarkable range expansion in the intervening years. *Mauritaniscus littorinus* is now widely distributed throughout the Bay Area, where it was the third most frequently encountered littoral species (found at 22 sites), and is also commonly found along the California coast from San Francisco Bay to San Diego County (Schultz et al. 1982).

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LITERATURE CITED

- ARCANGELI, A. 1932. Isopodi terrestri raccolti dal prof. Silvestri nel Nord-America. Boll. Lab. Zool. Gen. Agra. 26: 121-141.
- DANA, J. D. 1853. Crustacea. Pp. 687-1618 in United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N. Vol. 13. C. Sherman, Philadelphia, Pennsylvania.
- DOLLFUS, A. 1895. Voyage de M. E. Simon dans l'Afrique australe (Janvier-Avril 1893) crustacés isopodes terrestres. Mem. Soc. Zool. Fr. 8:345-352.
- EDNEY, E. B. 1953. The woodlice of Great Britain and Ireland. Proc. Linn. Soc. Lond. 164:49-98.
- ESSIG, E. O. 1926. Insects of western North America. MacMillan, New York, New York.
- FERRARA, F., AND S. TAITI. 1989. A new genus and species of terrestrial isopod from Malaysia (Crustacea, Oniscidea, Platyarthridae). J. Nat. Hist. 23:1033-1039.
- GARTHWAITE, R. L. 1988. *Detonella papillicornis* (Richardson) (Isopoda: Oniscidea: Scyphacidae) from Bolinas Lagoon, California. Bull. S. Cal. Acad. Sci. 87:46-47.
- GARTHWAITE, R. L., F. G. HOCHBERG, AND C. SASSAMAN. 1985. The occurrence and distribution of terrestrial isopods (Oniscoidea) on Santa Cruz Island with preliminary data for the other California islands. Bull. S. Cal. Acad. Sci. 84:23-37.
- GARTHWAITE, R. L. AND C. SASSAMAN. 1985. *Porcellionides floria*, new species, from North America; provinciality in the cosmopolitan isopod *Porcellionides pruinosus* (Brandt). J. Crust. Biol. 5:539-555.
- GRUNER, H.-E. 1966. Isopoda, part 2. Pp. 151-370 in Die Tierwelt Deutschlands, M. Dahl and F. Peus, eds. Gustav Fischer Verlag, Jena.
- HATCH, M. H. 1939. Records of terrestrial Isopoda or sow bugs from North America. Amer. Midland Nat. 21:256-257.
- . 1947. The Chelifera and Isopoda of Washington and adjacent regions. Univ. Wash. Publ. Biol. 10:155-274.
- JACKSON, H. G. 1923. A revision of the isopod genus *Ligidium* (Brandt)—Crustacea. Proc. Zool. Soc. London 1923: 823-839.
- LOHMANDER, H. 1927. On some terrestrial isopods in the United States National Museum. Proc. U.S. Natl. Mus. 72: 1-18.
- MENZIES, R. J. 1950. Notes on California isopods of the genus *Armadilloniscus*, with the description of *Armadilloniscus coronacapitalis* n. sp. Proc. Cal. Acad. Sci. 26:467-481.
- MILLER, M. A. 1936. California isopods of the genus *Porcellio* with descriptions of a new species and a new subspecies. Univ. Calif. Pub. Zool. 41:165-172.
- . 1938. Comparative ecological studies on the terrestrial isopod crustacea of the San Francisco Bay region. Univ. Calif. Pub. Zool. 43:113-141.
- . 1975. Phylum Arthropoda: Crustacea, Tanaidacea and Isopoda. Pp. 277-312 in Light's manual: intertidal invertebrates of the central California Coast, R. I. Smith and J. T. Carlton, eds. University of California Press, Berkeley, California.
- MULAIK, S. AND D. MULAIK. 1942. New species and records of American terrestrial isopods. Bull. Univ. Utah 32:1-23.
- AND ———. 1943. New Texas terrestrial isopods with notes on other species. Bull. Univ. Utah 34:3-15.
- RICHARDSON, H. 1904. Isopod crustaceans of the northwest coast of North America. Harriman Alaska Expedition 10: 213-230.
- . 1905. A monograph of the isopods of North America. Bull. U.S. Nat. Mus. 54:i-liii, 1-727.
- RICKETTS, E. F., AND J. CALVIN. 1968. Between Pacific tides. Stanford University Press, Stanford, California. i-xxvi, 652 pp.
- SCHULTZ, G. A. 1984. Four species of *Alloniscus* Dana, 1854, from the west coast of North America and Hawaii (Isopoda, Oniscoidea). Crustaceana 47:149-167.
- SCHULTZ, G. A., R. L. GARTHWAITE, AND C. SASSAMAN. 1982. A new family placement for *Mauritaniscus littorinus* (Miller) n. comb. from the west coast of North America with ecological notes (Crustacea: Isopoda: Oniscoidea: Bathytropidae). Wasmann J. Biol. 40:77-89.
- STUXBERG, A. 1875. Om Nord-Amerikas oniscider. Oefvers. k. Svensk. Vet. Akad. Forh. 32:43-63.
- TAITI, S., AND F. FERRARA. 1986. Taxonomic revision of the genus *Littorophiloscia* Hatch, 1947 (Crustacea, Isopoda, Oniscoidea) with descriptions of six new species. J. Nat. Hist. 20:1347-1380.
- VAN NAME, W. G. 1936. The American land and fresh-water isopod crustacea. Bull. Amer. Mus. Nat. Hist. 71:1-535.
- . 1940. A supplement to the American land and fresh-water isopod crustacea. Bull. Amer. Mus. Nat. Hist. 77:109-142.
- WACHTLER, W. 1937. Die Tierwelt Mitteleuropas. Isopoda (Asseln). 2:225-317.